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Number 2

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FLOYD SMITH AERIAL LIFE PACK
TESTING AIRPLANE WING RIBS
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PUBLISHED SEMI-MONTHLY
BY
THE GARDNER--MOFFAT CO., INC.
HARTFORD BUILDING, UNION SQUARE
22 EAST SEVENTEENTH STREET, NEW YORK

Entered as second-class matter, August 3, 1916, at the Post Office at New York, N. Y., under act of March 3, 1879




# The Aerial Performance of the Year

**CREW OF U. S. MARTIN "ROUNO THE RIM FLYER"—Left to right: Colonal Hartz, Lieuts. L. A. Smith and E. E. Harmon, Sergeants John Harding, Jr., and Jeramiah Tobias**

When the Martin Bomber commanded by Colonel R. S. Hartz and piloted by Lieut. E. E. Harmon landed at Bolling Field, Washington, D. C., on November 9th, it set a new milestone in the aeronautical history of this country—having successfully completed a trip of 9823 miles around the Rim of the United States.

The Martin "Round the Rim" Bomber set a record for sturdy efficiency that is absolutely unparalleled in the history of aviation. The feat of circum-aviating the States wound up a year of consistent, high class performance without an equal, a record of a total of 225 hours and 24 minutes covering a total of practically 20,000 miles.

This particular airplane undoubtedly has more noteworthy cross country performances to its credit than any other airplane in this country. In addition to its recent trip around the United States, in the course of which it set a new American non-stop record of 857 miles in 7 hours and 10 minutes it has made the following noteworthy cross country flights:

| | |
|---|---|
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| Washington to New York and return (Four times) | 450 miles |
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| Washington to Dayton and return (Two times) | 1000 miles |
| Washington to Langley Field and return | 400 miles |

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FEBRUARY 15, 1920

# AVIATION AND AERONAUTICAL ENGINEERING

VOL. VIII. NO. 2

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THE GARDNER, MOFFAT COMPANY, Inc., *Publishers*

HARTFORD BUILDING, UNION SQUARE, 22 EAST SEVENTEENTH STREET, NEW YORK

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# AVIATION AND AERONAUTICAL·ENGINEERING

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TECHNICAL EDITOR
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BUSINESS MANAGER

Vol VIII February 15, 1920 No 2

THE New York Aeronautical Show which will open its doors on March 6 at the 71st Regiment Armory promises to be by far the most important public manifestation of the aircraft trade this year

The preceding exposition was chiefly a war show. It afforded the public the first comparative view of America's war effort in the air, restrictions of censorship and of other war time measures having generally prevented the average citizen from examining at leisure the fighting aircraft of the United States before that date. The short time that elapsed between the Armistice and the last aircraft exposition, on the other hand, prevented most manufacturers from designing purely commercial types of aircraft, although a few meritorious efforts were made in that direction.

The coming Aeronautical Show will not labor under that handicap. Sufficient time has passed since the ending of the war to permit aircraft designers to develop machines specially designed to satisfy the requirements of aerial transport and pleasure flying. A large number of these machines has, during the last summer, already demonstrated to the public its value for peaceful pursuits. Many new types have since been developed as the result of the lessons learned by designers from actual operation of flying machines and airships. More attention is now being paid to the comfort of passengers, which item must obviously be one of the very important requirements of commercial aircraft. This not only means the fitting of comfortable armchairs and the allowance of sufficient leg room, but also the absorbing of noise and vibration, suitable ventilation of closed cabins, ease of access and egress, etc. That all these problems have retained much of the attention of aircraft designers will be obvious to those who will visit the Aeronautical Show, where comfortably equipped cabin airplanes and seaplanes will form a center of attraction. To the sportsman high speed racing airplanes and two-man airships will offer all the exhilaration the navigating of the air offers.

Altogether this exposition will afford all those who are not yet familiar with the features of modern commercial aircraft an excellent opportunity for familiarizing themselves with the latest products of the aircraft industry.

## Interaction Between Propeller and Fuselage

Airplane designers often puzzle over the question of the interference, or interaction, between the propeller and the fuselage of an airplane. How far is the thrust and efficiency of a propeller influenced by the presence of a body in its rear? What are the slipstream corrections to be applied in order that a correct estimate of fuselage resistance in the presence of a tractor screw may be made?

These questions are still far from being satisfactorily answered by recent investigations. It would appear that both propeller thrust and efficiency may increase owing to the presence of the fuselage, while the resistance of the latter itself is increased. The two effects are thus seen to compensate one another. In fact, the calculated effects of a combination of propeller and fuselage is identical, just as it would work with no obstruction in its rear, and of a fuselage meeting the air of ordinary mental results when the two are actually tested together

## Engines for Altitude Work

While much useful work has been done in this country on the turbo-compressor, there is a danger that other methods of obtaining efficient engine operation at altitude may be neglected.

The recent German record was attained by Lieutenant Liebman, who, with a B & W engine, attained a height of 9620 meters on June 6, 1919. This was done by the use of super-dimensioned cylinders, over-compressor and a special form of carburetor.

The engine had six cylinders and developed a constant 200 hp at 5500 meters. Gasoline was used under an over-pressure of about one-fourth of an atmosphere, and the throttle consisted of five valves, three used for normal flight and two for flights over 2000 meters

While full particulars of the engine are not yet available, it is interesting to note what can be done in the way of altitude operation without the use of the turbo-compressor.

## Balancing of Tail Surfaces

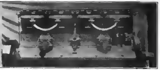
The design of balanced surfaces does not yet seem to have reached the stage of complete standardization. In the ordinary method of balancing surfaces there was always the risk of over-balancing. An interesting idea in this regard is that brought up by a French designer, Levasseur. The ailerons and elevators in one of his designs are balanced by having their leading edges arranged in the form of saw-teeth.

While this may produce a slight amount of turbulence when the surfaces are out of normal, the arrangement may have certain structural advantages.

In another recent French design, the ailerons are balanced by small auxiliary planes upon the main planes, following German practice. Both these tendencies are worthy of notice.

# New Aircraft Engines at the Paris Aero Show

Clerget-Blin 10 Hp Engine



Clément-Bayard 300 Hp Airship Engine

(C) International

In the accompanying illustrations are shown some of the most striking aircraft engines that were exhibited at the recent Aero Show in Paris. The following data and particulars are available regarding these engines, several of which have not as yet been tested in flight

*Clerget-Blin* —The Clerget-Blin 2-cyl horizontal opposed model is probably the most low-powered aircraft engine on the market. It develops 10 hp and recalls in its general arrangement the Nieuport 35 hp engine of 1911, which was a pioneer in this design.

*Clément Bayard* —The Clément-Bayard 300 h p model is an airship engine, which has been extensively used in the French airship service The six cylinders have 165 mm bore, 225 mm. stroke and deliver their rated power at 1200 r.p.m.

The water jackets are of copper, corrugated, each cylinder being separately encased Overhead valves, two per cylinder, of an extremely small size are effectually operated by water-cooling the interior of the valve itself by a water passage through the stem An interesting feature is the use of a minute central valve which is employed as a decompressor for starting The magnetos are driven through a helical coupling advance and retard gear which can be retarded by hand for starting and which then automatically advances itself as the engine gains speed

*Salmson* —The Salmson engine shown in the accompanying illustrations is noteworthy for being the first air-cooled model

Salmson 9-Cyl. 240 Hp Engine

Potez 4-Cyl. 50 Hp Engine

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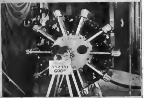
Peugeot 12-Cyl. 600 Hp V-Type Engine

Peugeot 16-Cyl. 500 Hp. X-Type Engine

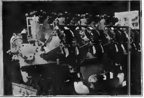
Sega 7-Cyl. Rotary-Type Engine





Anzani 20-Cyl. 600 Hp. Radial-Type Engine

Panhard 16-Cyl. 700 Hp Fan-Type Engine



Lorraine-Dietrich 24-Cyl. 1000 Hp Fan-Type Engine

(C) International

ever produced by this firm. It has nine cylinders, 125 mm. bore and 170 mm. stroke and weighs 230 kg. for 245 hp. at full power, that is, 0.94 kg. per hp. Its cruising power is 230 hp., when its weight becomes slightly over 1 kg. per hp.

*Potez.*—The Henri Potez 4-cyl. engine is shown herewith mounted on a tractor biplane of the same firm. It is placed with the crankshaft vertical so that all cylinders may be evenly cooled. The propeller is driven by bevel gearing.

*Peugeot.*—Of the two models illustrated, the 12-cyl. 600 hp. engine is a water cooled V-type, 160 mm. more and 170 mm. stroke. It delivers its rated horsepower at 1600 r.p.m. The other engine, which is built under the Jouffret licence is a 16-cyl. X-type. The cylinders are 130 mm. in bore, with a stroke of 170 mm., and develop 500 hp. at 1,400 r.p.m. They are arranged in four blocks of four, set in the form of an X.

*Anzani.*—The 600 hp. radial Anzani is, unlike the other products of this firm, of the water-cooled type. The twenty cylinders are arranged in two rows of ten, one behind the other, with a common water jacket covering each pair of cylinders. This arrangement has obviously been adopted because of the difficulty of properly cooling the rear row of cylinders by air.

*Sega.*—The Sega engine is a rotary of novel design. The cylinders are arranged to oscillate on trunnions mounted on a steel ring carried from bearings on the crankcase by radial arms. This permits the connecting rods to be rigidly attached to the aluminum pistons. The crankcase is open to the air, so that the pistons are air-cooled.

One large exhaust valve is fitted to each cylinder head, and one automatic inlet valve in the cylinder side. Large auxiliary exhaust ports are cut in the cylinder walls at the end of the piston career.

*Panhard-Levassor.*—The Panhard-Levassor 16-cyl. 700 hp. engine is of the fan type, with the cylinders arranged in four successive rows of four. The bore is 145 mm. and the stroke is 170 mm. The engine is rated 720 hp. at 1600 r.p.m. and weighs 700 kg. dry. There are two overhead camshafts, one between each of the outer Vees, which operate via pushrods two inlet and two exhaust valves in each cylinder head. Between each of the outer Vees are two induction manifolds, each pair fed from a twin carburetor mounted at the end of the crankcase opposite to the propeller. Four 8-cyl. magnetos are mounted on each end of the crankcase, and ignite each cylinder through two plugs.

*Lorraine-Dietrich.*—The Lorraine-Dietrich 1000 hp. model is undoubtedly the most powerful aircraft engine produced so far. It is of the three-row fan type, which may be described as a V type engine with a row of vertical cylinders between the Vee, each row having eight cylinders. The bore is 125 mm. and the stroke 200 mm. and the cylinders are set at 60 deg. between each row. The connecting rods of the vertical row are the master rods, to which are coupled the connecting rods of the outer rows. The connecting rods are of tubular construction. Two double carburetors on the on one side of the engine, and two single carburetors on the other side, each of the six carburetors feeding a block of four cylinders.

## The German Parseval Airship PL-27

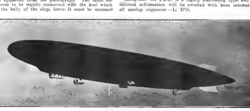
The accompanying illustration is photographic evidence tending to disprove the belief, quite general among airship engineers, that during the war Germany abandoned the construction of nonrigid and semirigid airships in order to concentrate upon the production of rigids of Zeppelin and Schütte-Lanz design. The airship here shown is the PL-27 built by the Parseval Co. (Luftfahrzeug Gesellschaft) of Bitterfeld, Prussia, which firm was well known before the war for its nonrigid ships fitted with girdle suspension and with two compensating ballonets.

It may be noted at first glance that the PL-27 differs fundamentally from pre-war Parsevals by its higher fineness ratio, the use of a cruciform empennage and the fitting of the cars in a manner reminiscent of the 1914 Schütte-Lanz—from which the L-30 Zeppelin class was incidentally developed in 1916. Like the S.L.II, the PL-27 has a separate control car forward, while the power plant is split up in four power cars, arranged in the "quadrilateral" fashion which has become famous on the super-Zeppelins. How these cars, and in particular the wing cars, are suspended from the hull is not quite apparent from the photograph. The three coaxial cars seem to be rigidly connected with the keel which runs along the belly of the ship, hence it must be assumed that the keel itself is rigid in its entire length and is not a hinged affair of the kind used on the Gross-Basenach and the Italian "Military" airships. As the wing cars also appear to be rigidly attached to the underside of the hull, it may be supposed that the keel flares out on either side sufficiently to afford rigid points of suspension to the wing car struts.

The keel girder is obviously trussed to the envelope by means of an internal rigging system, but the nature of this is, for lack of data, a matter for speculation. It is possible that the keel is supported by circumferential fabric strips which surround the gas holder proper, such as was the case in the Siemens-Schuckert airships of 1911, the patents for which were acquired by the Prussian army. The excellent streamline of the PL-27 is noteworthy, for it is rather unusual for a semirigid of such large size to hold its shape so well.

That this airship was built for war service, may be presumed from the gun platform which is fitted on top of the hull, just forward of the after car.

Altogether the PL-27 is a highly interesting type and additional information will be awaited with keen interest by all airship engineers.—L. D'O.



THE GERMAN PL-27, A PARSEVAL SEMI-RIGID OF LARGE SIZE

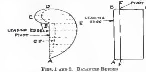
# Balanced Control Surfaces on Aircraft

By R. N. Wing, M.S.A.E.
*Goodyear Tire & Rubber Co.*

The purpose and the value of the balanced control surfaces used on the larger size airships and air planes, are not fully appreciated by persons unfamiliar with the fundamentals of aerodynamics.

The layman casually observing a typical balanced aileron, elevator or rudder, Fig. 1 and 2, and noting the comparatively small portion of it which is located in front of the hinge line or pivot, will naturally think that this is done for appearance rather than for any practical reason. When told that its real purpose is to balance the air force on the movable control surface about its pivot in order to relieve the pilot from unnecessary manual exertion in operating the controls, he does not comprehend how such a small surface will accomplish this desired result.

The reason for this fact is that the center of the air pressure on a flat plate or a double cambered surface is not located half way back from the leading edge as is its center of gravity, but is only about 21 per cent. aft of the leading edge for small angles as shown by the accompanying curves on Fig. 3.




FIGS. 1 AND 2. BALANCED RUDDER

These curves were obtained from wind tunnel tests on models. The double cambered surface tested had a thickness of 10 per cent. of its depth and an aspect ratio of 4, while the flat plate had an aspect ratio of 6. The difference in aspect ratios would have only a very slight effect if any on the location of the center of pressure. It should be noted that the center of pressure on the cambered surface remains nearly constant at about 21 per cent. of the depth aft of the leading edge up to an angle of inclination to the wind of 7½ deg., increasing to 20 per cent. at 14 deg., while that on the flat plate starts at 22 per cent. and gradually moves backward to 39 per cent. at 20 deg.

There are two methods of obtaining this balancing effect, namely:—

1. By moving the pivot points aft to the center of pressure, say about 20 per cent. aft of the leading edge on a rectangular surface Fig. 2, and
2. By moving the center of pressure forward to the pivot or hinge line by the extension of part of the surface in front of the hinge line Fig. 4.

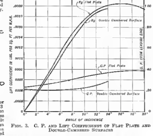
The first method is that used on the first U. S. Navy airship and on the British R-34, and is much simpler to calculate.

The second method is that used on most of the large airplanes and flying boats on the latest types of airships built in the United States, and is more or less of a cut and try method.

In balancing a control surface it is practical to slightly under-balance it, arranging the surfaces so that the center of the pressure at small angles of incidence will come from 1 in. to 2 in. aft of the pivot. This distance will, of course, increase as the angle is increased.

*First Method.*—It might be stated here with regard to the first method above mentioned that when on an aircraft there is a fin or stabilizer surface directly in front of the movable surface, as the control surface is moved about its pivot its leading edge moves away from the fin and is partly shielded from the wind by the fin, with the result that the shielded center of pressure comes somewhat further aft than 21 per cent., and in such cases the pivot may need to be located 25 to 30 per cent. aft of the leading edge as noted on the R-34.

*Second Method.*—The second method is calculated by dividing the surface into horizontal strips parallel to the longitudinal axis of the ship, determining the location of the center of pressure on each of these strips aft of the leading edge and either calculating or planimetering the areas of these




FIGS. 3. C. P. AND LIFT COEFFICIENTS OF FLAT PLATE AND DOUBLE-CAMBERED SURFACES

strips. A center of pressure curve may be drawn through these points as shown in Fig. 1. A summation is then made of the moments due to the area of each strip times the distance of its center of pressure from the pivot point, considering distance aft of the pivot as positive and those forward of pivot as negative. This total moment is then divided by the total area of the surface in order to obtain the location of the resultant C. P. of the control surface aft of the pivot.

*Examples.*—For example we will take the simplest case of rectangular shaped unbalanced and balanced portions as shown in Fig. 4.

Unbalanced area $ABGF = 2 \times 4 = 8$ sq. ft.

C. P. of unbalanced area $= .21 \times 2 = .42$ ft. aft of leading edge and pivot

Balanced area $EGCD = 3 \times 1 = 3$ sq. ft.

C. P. of balanced area $= .21 \times 3 = .63$ ft. of leading edge.
$= .63 - 1.0 = -.37$ ft. aft of pivot.

Moment of unbalanced area $ABGF = 8 \times .42 = 3.36$ cu. ft.

Moment of balanced area $EGCD = 3 \times (-.37) = -1.11$ cu. ft.

Resultant moment $= 3.36 - 1.11 = 2.25$ cu. ft.

$$\text{Resultant C. P.} = \frac{2.25}{11} = .204 \text{ ft.} = 2.45 \text{ in. aft of pivot.}$$

*Incorrect Method.*—An incorrect method of figuring the balancing effect and one which might seem logical at first glance, is to consider that the unbalanced portion includes all

of that aft of the pivot, i. e. *tBCH* and the balanced portion as *DEFH*

Moment of portion aft of pivot = 2 x 5 x .21 x 2 = 4.20

" " ahead of pivot = 1 x 1 x (.21 x 1—1.0) = .79

Resultant moment = 3.41 cu. ft.

$$\text{Resultant C. P.} = \frac{3.41}{11} = .31 \text{ ft.} = 3.72 \text{ in. aft of pivot as}$$

compared with 2.45 in. by the correct method.

The incorrectness of this latter method is that it assumes that the lower section *EGDC* is composed of two separate double cambered surfaces *DEFH* and *FGCH* which is not true.

In designing control surfaces it is better to have as large an aspect ratio as practical, not only because such a surface is more efficient aerodynamically but also in order that the center of pressure on the unbalanced portion will be nearer to the pivot and consequently will require a smaller balancing surface which in turn will permit a lighter construction.

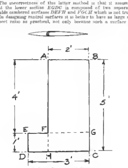



Fig. 4 Balanced Rudder

It is not the purpose of this article to minimize the value and importance of a wind tunnel test on a balanced control surface where such test is possible, as there are so many things which enter into the action of the air that pure mathematics is not a substitute but merely an aid to a wind tunnel test in making a design. However, in case of an ordinary control surface which will not require excessive air forces upon it, the above method will usually suffice.

## A Study of Airplane Engine Tests

The following is a resumé of Report No. 46 of the National Advisory Committee for Aeronautics, being A Study of Airplane Engine Tests, by Victor R. Gage.

This report is a study of the results obtained from a large number of tests of an Hispano Suiza airplane engine in the altitude laboratory of the Bureau of Standards. It was originally undertaken to determine the heat distribution in such an engine, but may other factors are also considered as bearing on this matter.

So many variables enter into the testing of multicylinder internal combustion engines that even where every effort has been made to keep conditions constant the results of a large number of tests must be studied in order to reach sound conclusions. This has been done in the present case. Graphical methods of expressing the various relations have been used where possible, and the results plotted in a wide variety of ways to check their accuracy. The use of logarithmic coordinate paper has permitted the plotting of many of the relations as straight lines.

Considering the tests as a whole, there are three major variables: Speed, altitude, and horsepower. The temperature during the tests was maintained practically constant. The loss in power through friction was assumed constant at any given speed regardless of altitude. This appeared to be justified, as will be described later. Indicated horsepower has been considered as brake horsepower plus friction horsepower. Indicated horsepower appears to decrease in density proportion to decrease density of the air. Its decrease with increase in altitude is due only to the fact that a variation in altitude necessarily implies an increase or decrease in density. For a given temperature, density is directly proportional to barometric pressure. Hence, the graphical representation of the variation of indicated horsepower with barometric pressure, when plotted on logarithmic coordinates, will be a straight line whose slope is unity.

### *Principal Results*

A study of the heat distribution under the various conditions shows that:

(1) The brake thermal efficiency remains constant at about 24 per cent on the ground at all speeds. As the altitude is increased its value drops to about 20 per cent, the maximum value at altitudes occurring at a speed of about 1,600 r.p.m. The indicated thermal efficiency remains nearly constant at 26 per cent for all speeds and altitudes.

(2) The heat lost in the exhaust is at a maximum at 1,900 r.p.m. at all altitudes, and amounts to almost 50 per cent of the heat supplied on the ground, decreasing to about 40 per cent at 30,000 ft. altitude.

(3) The heat lost through friction varies from 2 per cent at 1,700 r.p.m. and 3 per cent at 2,100 r.p.m. on the ground to 6 and 8 per cent, respectively, at 30,000 ft. altitude.

(4) The heat lost in the jacket water is about 17 per cent of that supplied at all speeds on the ground, increasing to 28 per cent at 2,100 r.p.m. and 35 per cent at 1,300 r.p.m. at 30,000 ft.

Due to the fact that the heat supplied in the gasoline varies with altitude, the above percentages are not absolutely accurate. The heat supplied appears to be proportional to the density of the air up to about 10,000 or 15,000 ft. altitude. As the density is further decreased relatively more gasoline is necessary and the proportionality between heat supplied and density ceases. The heat utilized and lost appears to follow about the same relation as the heat supplied.

Fuel consumption varies from a minimum of 0.50 pound per h.p. per hour on the ground to a maximum of 0.60 at 30,000 ft.

### *Relation of Power to Speed*

The study of the relation between power and speed shows that the increase in power through increase of speed is at a maximum on the ground; the gain becoming less as the altitude is increased, until at 30,000 ft. there is practically no gain in power with increase in speed above about 1,700 r.p.m. After reaching a sufficient altitude, the curves show that the engine would stall at from 450 to 500 r.p.m., with wide-open throttle, as there would not be sufficient power to overcome the friction losses.

The power lost in friction is a very important factor in the performance of the engine at high altitudes. While its value can not at present be determined with extreme accuracy, owing to the fact that no satisfactory indicator for high-speed internal-combustion engines is now available, a careful investigation was made of all the data bearing on this question. After carefully considering these results and the fundamental laws governing the subject, it is concluded that friction mean effective pressure is practically a constant for a given speed and is independent of altitude.

Considering the matter of carburetion, the results indicate that the optimum proportion of gasoline to air for maximum fuel economy is not a constant at constant speed with change in altitude. Apparently the leanest mixture could be used at about 15,000 ft. with greater weight proportions of fuel to air at other altitudes.

# An Approximate Method of Testing Airplane Wing Ribs*

By N. W. McLachlan, D.Sc.Eng., M.I.E.E.

*Introduction.*—The stresses which occur in a wing rib when an airplane is in flight are due chiefly to the tension in the warp and weft threads of the fabric. These tensions are the resultants of the initial tensions, and those caused by the air pressure, either positive or negative, on the fabric constituting the upper and lower surfaces of the wing. The resultant tensions under given conditions of flight depend on (a) the shape of the wing section, (b) the spacing of the ribs, (c) the method of attachment of the fabric to the wing, (d) the tautness of the fabric after doping. The magnitudes of the stresses which occur in the ribs and the attached framework depend on the design of the wing. The magnitudes of the stresses for a wing of definite design depend, among other things, on (a) the weight of the airplane, (b) the angle of incidence of the chord. In prescribing a test for airplane wing ribs, the case in which the distribution of air pressure over the section is such

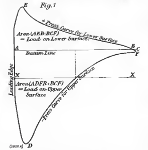


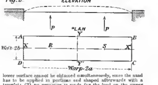

Fig. 1

that the stresses, due to normal loading, are most liable to cause fracture at the smallest load factor, should be chosen (load factor $= \dfrac{\text{total load at failure}}{\text{unit load.}}$) This case will generally occur when the angle of incidence is such that the airplane stalls. The stresses are not greatest when stalling occurs, because in this case the airplane just supports its own weight, and the load is, therefore, normal in magnitude. Stresses of greater magnitude occur in spinning and in flattening out after a nose dive. In these latter cases, however, the load on the machine is greater than its own weight, and the stresses are therefore in excess of those under normal loading, although the ratio $\dfrac{\text{maximum stress on rib}}{\text{load on rib}}$ is less than that when stalling occurs.

*Distribution of Air Pressure over the Wing Section.*—Suppose that the distribution of the air pressure on the upper and lower surfaces, normal to the chord, when the airplane is on the point of stalling, i. e., when the lift coefficient is a maximum, is given by Fig. 1.† The maximum rate of loading occurs near the leading edge, and causes large stresses in the portions of the ribs between that edge and the front spar. It is required to apply a system of forces to the ribs such that the stresses therein will be the same as those produced by the forces acting on the fabric constituting the upper and lower surfaces of the wing, according to the distribution shown in Fig. 1. Also, the forces should be modified to comply with the distortion of the wing section and the consequent alteration in the air pressure distribution as the load on the ribs is increased up to that at which fracture occurs. The desired distribution of pressure and stresses could be obtained if a portion of the wing were tested in a large wind channel. In order to cause fracture, which is the criterion by which ribs are judged, it would be necessary to obtain a wind speed of over 250 m.p.h. For ordinary laboratory work, this procedure is clearly out of the question.

By inverting the wing, placing it on suitable supports and loading the lower surface with sand, in accordance with the configuration of Fig. 1, the effect of the air pressure on that surface would be reproduced, provided the pressure at any point on the surface was proportional to the height of sand at that point. The pressure on the surface is not proportional to the height, however, and may be zero if the sand is wet. The latter condition, i. e., wetness, is essential if the configuration of the diagram is to be maintained at several times normal load. Even if the method were satisfactory, i. e., if the pressure was proportional to the height, there would be two defects remaining: (1) The whole of the load distribution on the lower surface cannot be obtained simultaneously, since the sand has to be applied in portions and shaped afterwards with a templet; (2) no provision is made for the load on the upper surface.

Fig. 2




In laboratory tests the effect of air pressure distribution can only be represented approximately. This is accomplished most readily by applying a series of static loads to the ribs, due consideration being given to the way in which the load is transmitted from the fabric to the wing framework.

*Load Distribution in Warp and Weft Threads of Fabric.*—The effective air pressure acting at any part of the upper or lower surface of a wing depends, for given conditions of flight, on the position of the vent holes. These are usually situated in the fabric on the lower surface at a distance of 1 in. to 1½ in. from the trailing edge. In Fig. 1, this distance has been set off to scale, on a horizontal line, from the right extremity of the curve, and projected vertically upwards to meet the lower surface pressure curve in the point B. Through this point a horizontal line A B C is drawn. This is the datum line, or line of pressure within the wing. All pressures above this line are positive (pressure on lower surface), and below the line are negative (suction on upper surface). Moreover, the areas above and below the line A B C represent, respectively, to some scale, the loads at 90 deg. to the chord, on the two surfaces of the wing. If the fabric were punctured at some part of the section other than near the trailing edge, the distribution of the pressure on the surfaces would be quite different. Suppose the vent holes were situated in the upper surface half-way between the leading and trailing edges, the datum line would then be XX', thus giving an enormous increase in pressure on the lower surface. Two vent holes at

* From *Engineering*.—The test described herein applies to ordinary ribs and not to box or compression ribs.

† The effect of drag will not be taken into account.

points of unequal pressure would mean a circulation of air inside the fabric. It is not proposed, however, to take those cases into consideration

*Case of Flat Rectangle.*—The load on the fabric caused by the air pressure is taken partly by the warp threads and partly by the weft. In order to obtain some idea of the tensions in the warp and weft threads of the fabric between two adjacent ribs, the case illustrated in Fig 2 will be considered A rectangular piece of fabric rendered non-porous, is clamped in such a way that gaseous pressure can be applied to the lower surface. The pressure of the gas causes tensions in both the warp and weft threads, and the fabric assumes a curved surface in order that the vertical components of the tensions round the periphery shall balance the vertical component due to the pressure The relation between the pressure and the

*Fig 3.*

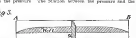



*Fig 4*

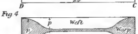
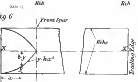



*Fig.5.*


*Fig 6*




tensions in the warp and weft at any point on the surface is given by the expression

$$p = \frac{T_1}{R_1} + \frac{T_2}{R_2}$$

where $p$ = pressure,
$T_1$ = tension in warp,
$T_2$ = tension in weft,
$R_1$ = rad. of curvature of warp in plane, containing normal to surface,
$R_2$ = rad of curvature of weft in plane, containing normal to surface.

This equation can be written $p = p_1 + p_2$, where $p_1$ and $p_2$ may be regarded as the pressures taken by the warp and weft respectively. Along the edge A B, no pressure is taken by the warp, since the radius of curvature is infinite. Along the axis XX' the tension and the strain in the warp have maximum values, although they are not uniform throughout the length of the fibres. Thus the tension in the warp threads in a section by a plane parallel to YY' increases from zero to a maximum at the centre, and then falls again to zero at the periphery of the rectangle Similarly with the tension in the weft fibres over a section by a plane parallel to XX'. The curve in Fig 3 represents roughly the variation in tension in the warp at the section YY'. If a is large in comparison with b, nearly the whole of the pressure between R and S is taken by the weft (see appendix).

Along the edge AD there is no tension in the weft, and since the pressure must be balanced, it is taken by the warp. The variation in tension in the weft along the axis XX' is sketched roughly in Fig 3 The relative amounts of load taken by the long and short sides of the rectangle will depend on the distribution of the tensions and on the radii of curvature of the fabric round the periphery. The distribution of pressure on the warp and weft is sketched in Fig 4. The unshaded area represents the vertical load on the edges AB, CD, and the shaded area, that on BC, AD.

*Case of Airplane Wing.*—In this case the fabric follows a curved surface before the application of air pressure, and the distribution of the tensions and pressures on the warp and weft during flight will be different from that shown in Figs. 3 and 4 The fabric may be considered to be firmly secured to the lower surfaces of the ribs since it is pressed thereon, and the components of the tensions parallel to the spars are equal and opposite on either side of a rib. The fabric on the upper surface, however, is attached to the ribs by means of string loops spaced from 3 in. to 5 in apart. In flight there is a tendency for the fabric to be lifted off a rib The string loops, however, are generally taut, and it will be assumed that the fabric is secured all along the upper surface of the rib Between the leading edge and the front spar, where the curvature of the upper surface is greatest, the fabric when viewed from above, is concave between the ribs, and it appears that it remains thus,* under all conditions of flight, unless of course it is very slack. This is due to the initial tension of the warp threads caused by doping Under this condition, air pressure (suction in this case) tends to relieve the tension in the weft and therefore the pressure at the rib, unless the fabric assumes the shape shown in Fig 5 Moreover, the fraction of the pressure taken by the warp threads, in the neighborhood of the leading edge is greater than that in the case of the rectangle. Since the curvature from the front spar to a point 5 in to 8 in from the trailing edge is small, practically the whole of the pressure over this region is taken by the weft threads (see Appendix).

*The assumed* distribution of pressure on the warp and weft threads of the upper surface of an airplane wing is illustrated in Fig 6. The lower half of the curve is of the form $y = kx^2$, and extends in the centre line of the front spar. The upper half of the curve is the image of the lower half. Since $y = b$ when $x = x_1$, we get $k = b/x_1^2$, and therefore $y = b(x/x_1)^2$. Thus the fraction of the pressure taken by the weft $= y/b = \left(\frac{x}{x_1}\right)^2$, at a point distant X from the leading edge, where $x < x_1$.

The fraction taken by the warp is evidently $1 - \left(\frac{x}{x_1}\right)^2$. By means of these formulae it is possible to calculate the fractions of the pressure on the upper surface, at the leading and trailing edges, taken by the warp and weft respectively. If the ordinates of the curve of Fig 1 are reduced in accordance with the first formula, the curves of Fig 7 are obtained

Since the curvature of the lower surface is different from that of the upper surface, the distribution of the pressure on the warp and weft will not be the same as that shown in Figs 6 and 7 However, since the curve of Fig 5 is only assumed, the same distribution can be used for the lower surface. This will probably cause too large a proportion of the pressure to be taken by the warp, but in testing the rib, such an effect is on the right side, since the rib will appear to be slightly weaker In Fig 7 the percentage of the load on the warp is rather too high owing to the centre line of the front spar being taken as 20 per cent of the chord from the leading edge. As a general rule this distance will be a smaller percentage, probably from 14 per cent to 18 per cent. If the distance had been 18 per cent, the loads taken by the warp on the upper and lower surfaces would have been approximately 15 per cent. and 7.5 per cent. The curves for this case are shown dotted in Fig 7.

The curves of Fig 7, suggest a rough method of obtaining the load on the wing. This is as follows. draw the centre line of the front spar at 90 deg to the chord to meet the pressure curve in the points Y,Y' and join AY, AY' (see Fig 7a) Then the shaded areas represent the load which is taken by the warp At the trailing edge, owing to the shape of the pressure curve, it is inconvenient to adopt this procedure. In this case curves may be sketched in, after the form of those shown in Fig 7

*Transference of Tensions in Warp and Weft to the Wing Framework.*—The warp threads are assumed to be parallel to the planes of the ribs, and the tensions in these threads are taken by the leading and trailing edges The directions of the resultant forces acting on these edges are inclined to the chord, and cause the ribs to be subjected to bending and compression For equilibrium, the compressional forces on each edge parallel to the chord† must have the same magnitude, and the forces on each edge at 90 deg to the chord must be equivalent to that portion of the air pressure diagram allotted to the warp threads.

Since the weft threads are assumed to lie in planes normal to the chord and to the planes containing the warp, the tensions in the former are transferred directly to the ribs. The components of the tensions parallel to the spars are equal, but opposite, on either side of a rib Thus the forces transferred to the rib are at right angles to the chord Since the fabric on the upper surface is held in place by string loops, the tensions in the fabric are transferred by these loops to the lower surface.‡ Therefore the whole of the load taken by the weft may be considered to act on the lower surface The vertical loading to be applied to the ribs and edges is obtained from Fig. 7.

When the warp threads do not lie in planes parallel to the ribs, there are components of the tensions in addition to those mentioned above. Similarly, when the weft threads do not lie in planes, normal to the chord and the planes of the ribs. These conditions exist to a certain extent in practice, thereby causing the transference of the load to the wing framework to be different from that described herein. Such conditions are very complex and will not be taken into account, since the method of testing the ribs is only approximate.

*Effect of Nose Ribs.*—In the foregoing, no account has been taken of the nose ribs which are situated midway between adjacent ordinary ribs, and secured to the leading edge and the front spar Owing to the diminution in the span of the fabric caused by the nose rib, the distribution of the tensions in the warp and weft will be different from that shown in Fig. 6. Since the fabric is not attached to the nose rib, the latter cannot take any vertical load when the machine is in flight, and it therefore merely supports the leading edge against the pull of the fabric (warp) When the wing is tested in the manner to be described hereafter, any pull applied to the leading edge is automatically transferred to the nose rib, which takes approximately its appropriate share. Moreover, the distribution of the tension in the fabric being assumed only, the effect of the nose rib on the load applied to an ordinary rib will be disregarded.

*Method of Obtaining Distribution of Load on the Wing Framework.*—Having determined the manner in which the load due to the air pressure on the fabric is taken by the wing framework, the method of obtaining the distribution of the load in practice will now be described Let A C K D L G, Fig. 7, represent the air pressure taken by the weft, which is to be applied as a vertical load on the ribs Divide the chord A B into a number of equal or unequal parts Then, the effect of the load distribution of Fig 7 on the lower side of the rib is approximately the same as that obtained by inverting the wing, (the chord being horizontal, and applying a series of concentrated loads equal in magnitude to the loads represented by the sections of Fig 7 The loads would act through the centres of gravity of these sections. If a large number of sections are taken, especially at the nose where the slope of the loading curve is greatest, the centre of gravity of any section may be assumed to be midway between the ordinates on either side. The fractions of the total load on the rib are calculated with the result represented in Fig 8.

The arrangement for loading the rib to correspond to the loads imposed by the tensions in the weft is obtained in practice by means of a system of levers, grouped as illustrated in Fig. 9 For the sake of convenience in manipulation, the levers are arranged in two groups (a) From the leading edge to the front spar, (b) from the front spar to the trailing edge When the requisite vertical forces P and Q are applied and the lengths of the levers are correctly adjusted, the pressure distribution is the same as that of Fig 8 The application of the load at a series of points along the chord, approximates to the effect of the tensions in the string loops attached to the fabric constituting the upper surface.

We have now to consider the other forces which act on the wing framework due to the tensions in the threads of the warp. These forces act on the leading and trailing edges. In Fig 7 the shaded portions at the leading and trailing edges represent respectively the vertical components of the load transferred by the fabric to these edges. The pull to be applied to the leading edge is $P = V/\sin\theta$, where V is the fraction of the total vertical load represented by the shaded areas on the left of Fig 7, and $\theta$ is the inclination to the chord of the resultant pull due to


Fig 7

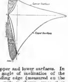



Fig 7a

the tensions in the warp of the upper and lower surfaces. In general $\theta$ will be less than the angle of inclination of the tangent to the surface at the leading edge (measured on the rib), but in practice the latter angle is chosen, since it is undesirable to cut the fabric in order to get the correct angle. The effect of this is a diminution in the value of H, but this has no serious consequences. The value of V at the trailing edge is also found from Fig. 7, and the inclination of the pull is arranged so that the horizontal components at the leading and trailing edges are equal, since for equilibrium this condition must be satisfied From Fig. 7 the distribution of the leading is as follows·

| | | Per Cent. |
|---|---|---|
| Load on warp of lower surface at leading edge = Area ABC | = | 0.2 |
| Load on warp of upper surface at leading edge = Area AGM | = | 22.6 |
| Load on weft of lower surface = Area ACKD | = | 26.1 |
| Load on weft of upper surface = Area ADLG | = | 44.6 |
| Load on warp of lower surface at trailing edge = Area KD | = | 0.5 |
| Load on warp of upper surface at trailing edge = Area LF | = | 0.7 |
| | | 100.0 |

The application of the forces to a rib and to the leading and trailing edges (as determined in the manner already indicated), is shown diagrammatically in Fig 10 Using a system of pulleys, cables, bars, and the small levers described above, the distribution of the load on the wing framework can be applied simultaneously by adding a weight to a suspended platform. A representative loading is as follows

| | Per Cent. |
|---|---|
| Horizontal component at leading and trailing edges | = 24.6 |
| Vertical component at leading edge | = 61.4 |
| Vertical component at trailing edge | = 1.2 |
| $\theta$ is assumed to be 60 deg. | |

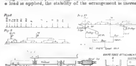
*Description of Apparatus Used during Tests.*—The levers, which are made from hard wood, preferably walnut, are fitted at one end with a knife-edge fixed securely in position. An adjustable knife-edge and an adjustable groove to receive the knife-edge of the lever in the next tier, are arranged on the lever as shown in Fig. 11. Adjustment is necessary in order that the apparatus can be used for testing wings with different chords. The knife edges of the lowest tier of levers rest in

* When the fabric is put on the wing it is made taut and then doped. Moreover there is considerable tension in the warp threads situated between two adjacent ribs, since it is easy to make the fabric taut between the ribs, where it is unsupported It is probable that the initial tension in the fabric at the nose of the rib is so large that the air pressure during flight is insufficient to lift the fabric between two ribs In practice, failure of the wing structure (ribs and leading and trailing edges) is most likely to be due to the pull of the warp

† If the compression ribs take a larger proportion of the compression than the ordinary ribs, this force as found from the loading diagram will be on the large side

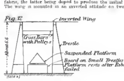
‡ As stated previously, it is assumed that the fabric is secured all along the upper surface of the rib

metal vees or grooves fixed to walnut blocks 1 in. square and about 3/8 in thick This is illustrated in Fig 11. Since the ribs are often only 1/2 in wide, it is evident that an arrangement such as that shown in Fig 10 when applied to *one* rib is unstable. In order to obtain stability, a set of levers is arranged over each of two adjacent ribs, similarly situated with regard to compression ribs, and the loads P and Q are applied by means of cross-bars resting on the uppermost levers of each set. To the centres of the cross-bars cables are attached, these connecting the systems of levers above and below the inverted wing. The cables pass through small holes in the fabric When a load is applied, the stability of the arrangement is increased




by the friction at the knife edges and that between the wooden blocks and the ribs, and by the lowering of the centre of gravity of the whole system due to the position of the load. If there is a tendency for the levers above the wing to fall sideways (this may occur if the lower surface has a large curvature), and if distortion occurs during test, thin strips of wood can be nailed to the uppermost levers and secured to uprights at the end of the wing. The load required to bend each stripe is negligible.

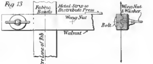
*Adjustment of Apparatus*—A portion of the wing about 8 ft in length, or of sufficient length to include at least four ribs, so that the two centre ribs are tested, is covered with fabric, the latter being doped to produce the initial tensions. The wing is mounted in an inverted attitude on two trestles,



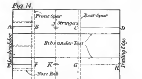

shaped as shown in Fig. 12, so that the chord and the centre lines of the spars are horizontal. The ribs to be tested are situated between the trestles Two pulleys with ball bearings are carried on horizontal cross-bars (the pulleys being at the centres of the bars), which are rigidly fixed to the trestles. The heights of the pulleys are arranged so that the forces at the leading and trailing edges are applied at angles $\theta_1$ and $\theta_2$, as shown in Fig 10 These forces are transmitted directly to each of the two ribs under test by means of double strips of fabric, 2 in. wide, doped to the lower surface of the wing and situated immediately over the ribs. The two stripe from each rib are held by an adjustable grip, of the form illustrated in Fig 13, and steel cables run from the centre of the grip over the pulleys to the system of bars beneath the wing The load is applied to a platform suspended from the lowest bar. The weight of the platform, the remainder of the mechanism and the portion of the wing under test, should be included in the load, although the mechanism is quite light. A general diagrammatic view of the apparatus as arranged for a test is illustrated in Fig 16, page 4.

Owing to the complexity of the apparatus it would not be practicable to test more than two ribs at once.* Moreover, during the test, the bracing effect of the remaining portions of the wing should be eliminated as far as possible, since it could not be relied on during flight. It is necessary, therefore, to cut portions about 3/4 in long out of the leading and trailing edges and stringers, on the outsides of the ribs under test, as shown at A, D, E, H, J and K in Fig 14 A certain amount of support is obtained from the spars, but this cannot well be eliminated.

Since the ribs are deformed as the load increases, the distribution of the air pressure would alter owing to the change in curvature of the wing section This cannot be allowed for




during the test The weakest part of the ribs is generally the nose or the trailing edge, especially the former if the front spar is not near the leading edge. Owing to the deflection of these parts, a large amount of load is taken by the fabric. As the test proceeds the fabric should be cut along A B, C D, E F and G H (see Fig 14) It is found in practice that the load factor of the portion of the rib between the spars is greater than that of the remainder of the rib, particularly the nose. The reason for this is to be found in the construction of the rib It is primarily designed so that any part of it will stand




a certain load factor The construction of the nose must, therefore, be such that it will not fail before this load factor is reached. This settles the dimensions of the webs and flanges on the two surfaces For simplicity of manufacture, the same section is preserved throughout, with the result that unless the spars are very widely spaced, the centre portion of the rib is much stronger than the remainder. Failure at the nose, i. e., between the leading edge and the front spar, is partly due to buckling and partly to bending and shear Compression failures often occur in the web of the centre portion of the rib, but these are not always serious.

*Measurement of Deflection of Upper Surface of Rib.*—A simple way of measuring the vertical displacement of any point on the upper surface of a rib (which is underneath when the

* Four ribs can be tested by placing the blocks of the lever mechanism midway between two adjacent ribs. The span between the two ribs is bridged by wooden bars on which the blocks rest. As a general rule this procedure is only adopted when the spacing of the ribs is small



wing is inverted) is to attach scales,* suspended by string so that they always remain vertical, at various points along the rib, from the leading to the trailing edge. The vertical displacement is measured by means of a surveyor's level Since the spars are deflected also, it is necessary to measure these deflections and to reduce the deflections of the other parts of the rib to a line through the spars as datum. Within certain limits of loading, the distance between the upper and lower flanges of a rib is approximately constant. Knowing the vertical displacement of the upper flange, it is possible to draw the shape of the rib at various stages of loading The load

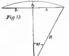
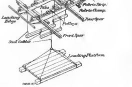



Fig. 16. APPARATUS FOR TESTING AEROPLANE WING RIBS




can be put on either in units (once normal load), or in half-units, up to three times normal load. After this, half-units should be used, and when fracture is imminent, small amounts should be added so that the correct load factor at fracture is obtained. The distance between the lower side of the suspended platform and the boards beneath it should never exceed a fraction of an inch after three times normal load. Thus, when failure occurs, the rib is not completely smashed and the failure can be inspected after removal of the fabric. Time must be allowed for the rib to attain its largest deflection corresponding to a certain load. This point is easily ascertained by reading the level periodically and noting when the deflection is constant. It is rather difficult to say what constitutes failure, but in tests of this nature a slight failure often occurs somewhere, at a load smaller than that required to produce serious failure or fracture. The latter, however, is probably the better criterion.

*The Magnitude of the Load to be Applied to a Rib*—The unit of load on the wings due to the air pressure in normal flight

= Wt of machine — Wt of wings, including top centre section $= W_m - W_w = W$ (lb)

This load is assumed to be divided up between the top and bottom wings, so that the ratio of the rates of loading is as 5 4. Since the rate of loading, i. e., the pressure per square foot of wing area, varies from the body of the machine to the wing tip, it is necessary to find the length of the uniformly-loaded wing of constant chord, equivalent to that of the actual wing This can be done if the distribution of pressure at various sections along the wing is known †

Let $A_1$ = Area of equivalent uniformly loaded top wings (square feet).

Let $A_2$ = Area of equivalent uniformly loaded bottom wings (square feet).

Then effective equivalent area of wings

$$= A_1 + 4/5 A_2$$
$$= A_1 + 0.8 A_2$$

∴ Mean air pressure per square foot of effective equivalent wing area at unit load =

$$\frac{W}{A_1 + 0.8A_2} = p_m \text{ (lb./sq. ft.)}$$

Since the rate of loading on the bottom wing is only 0.8 of that of the top wing, the units of load for ribs in the two wings will be in the ratio 0.8 to 1 respectively In general it is not worth while to make the ribs different in the two wings, so that the larger load unit can be used for both. The load placed on the platform is greater than the vertical load applied to the ribs, owing to the forces at the leading and trailing edges being inclined to the vertical. In the case cited above, the load on the platform plus that due to the mechanism and the portion of the wing under test, is 1.85 times the vertical load on the ribs, i. e., $W_1 = 1.85$ W

In conclusion, it should be mentioned that several sets of apparatus have been constructed and different types of rib tested. Practical difficulties would naturally be expected to arise in using such complicated apparatus This, however is not the case, for the stability of the levers and blocks is such that they remain on the rib excepting in the case of an absolute collapse. As stated previously, this should not be allowed to happen When the lengths of the levers have been adjusted to suit the chord of the wing and the latter is covered with fabric, the time taken to arrange the whole of the apparatus and conduct a test is about one hour and a half

## Appendix

Let the curve of Fig 15 represent the shape of the weft threads at YY' in Fig 2, and assume that this curve is an arc of a circle. If we make the further assumption that the tension is the same throughout the length of thread (this is, of course, not true in practice), the strain is constant throughout the length

$$\text{Strain} = \frac{\text{extension}}{\text{original length}} = \frac{\text{arc} - \text{chord}}{\text{chord}}$$
$$= \frac{R\theta - b}{b}$$
$$= \frac{R}{b}(\sin^{-1} b/R - b/R)$$

If $b/R$ is small, we may write $\sin^{-1} b/R = \frac{b}{R} + \frac{b^3}{6R^3}$

Thus strain $= \frac{R}{b} \cdot \frac{b^3}{6R^3} = \frac{b^2}{6R^2}$

Now $R = b^2/2h$, when $h^2$ is small compared with $b^2$.

Hence strain along the weft $= \frac{4h^2}{6b^2}$

Similarly the strain along the warp $= \frac{4h^2}{6a^2}$

$$\therefore \frac{\text{Strain along weft at centre}}{\text{Strain along warp at centre}} = (a/b)^2$$

If we assume, in addition, that the stress in pounds per inch of width, is proportional to the strain (strictly speaking this also is incorrect), then

$$\frac{\text{Tension in weft at centre}}{\text{Tension in warp at centre}} = (a/b)^2$$

If $a = 5b$, this ratio is 25/1

The above is a rough outline of the reason for neglecting the tensions in the warp threads between the spars of an airplane wing, in comparison with the tensions in the threads of the weft.

* Loaded wooden laths to which paper scales are attached, or on which scales are marked

† The variation occurs chiefly at the wing tip where the rate of loading falls off.

# The Edstrom Wire Wrapping Machine

In the January 1, 1920, issue of AVIATION there was given a short historical notice of the Edstrom wire wrapping machines. Some illustrations are now available which give a much clearer idea of this interesting instrument.

Fig 1 shows the Edstrom machine for making cable ter-

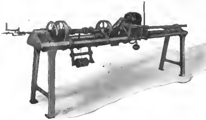


FIG 1 GENERAL VIEW OF THE EDSTROM WIRE-WRAPPING MACHINE

minals. To take care of long cables extensions of ten feet each are added up to the required length. This also shows, in part, measuring and bending mechanism.

Fig 2 illustrates the method of winding the wire on the cable. The latter is kept in perfect tension by use of lock-nut and spring against the spool and the wire around the stationary spindle, thereby getting the full tension from a special-strength wrapping wire used

Fig 3 shows a test machine specially designed for testing airplane cables up to any required length, since this only involves an extension of the frame. When test is to be made, the scale is set at the poundage wanted and when the cable is stretched to that amount, the bell rings.

Results quoted in the Jan. 1, 1920 issue as above, show that with unsoldered machine-wrapped cable terminals, with special strength wire, an efficiency of 100 per cent is invariably attained, far surpassing the efficiency of hand wound cable terminals

The Edstrom Co. is also developing a machine for hard-wire terminals which promises to give the same efficiency.

The mechanical wrapping of cable terminals constitutes one of the most interesting developments in airplane production of the last year or so The Edstrom Co. does not sell these machines, but undertakes to do wrapping for any airplane company, on any size of cable, or hard wire.

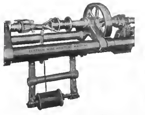


FIG 2. WINDING WIRE ON THE CABLE

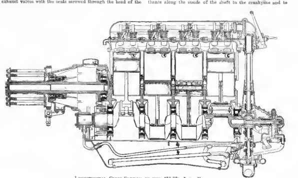
FIG 3 AIRPLANE CABLE-TESTING MACHINE



# The 450-Hp. Napier Lion Engine

The Napier Lion aeronautic engine has many points of interest The most noticeable feature of the latest model is the new type of water-jacket. There is now a separate jacket to each cylinder instead of a multiple jacket for each block of four cylinders. Weight is saved, and the new method of making a water-tight joint between the cylinder and the jacket is preferable to the old. In the former models the lower joint was made by a rubber ring, in the latest type the jackets are welded to the cylinders.

The Lion engine, which develops 450 b.hp at 2000 r.p.m., weighs only 1.80 lb per b. hp., without water, fuel or oil Its twelve cylinders are arranged in three sets in the "broad arrow" method. Each cylinder has two inlet and two exhaust valves with the seats screwed through the head of the



LONGITUDINAL CROSS-SECTION OF THE 450-HP. LION ENGINE

cylinder into the head casting The valves are operated by two overhead camshafts, and the cams act directly upon the tappet heads, the stems of which are screwed into the valve stems so that the clearance may be adjusted A spring locking ring secures the tappet head when the adjustment has been made

### *Starting Device*

The engine is started by pumping an explosive mixture into the cylinders and firing it by a hand-starting magneto. Linked control levers enable the two forward valves of each cylinder to be opened by hand. The air-pump is mounted in the cockpit, and by a two-way cock it can be used first to pump pure air to the cylinders to expel any foul gases that there may be in the combustion chambers, and then the explosive mixture is ready for firing The mixture is formed by pumping air through a vaporizer which is a form of spray carbureter

The three rows of cylinders are supplied with mixture, when running, by two carbureters, a single and a duplex type. The gas passages are water-jacketed. So far as the throttles, diffusion jets and altitude control cocks are concerned the carbureters resemble the HC7 type, but modifications have been made to adapt them to the Lion engine.

The altitude control system is that of reducing the supply of gasoline as the machine climbs. This is, of course, necessary, because as the air becomes rarefied the percentage of air to gasoline would become incorrect if the flow of fuel were not checked. There is a safety device which causes the control to shut automatically when the throttle is closed. This prevents the mixture being too weak when the pilot makes a long dive and flattens out.

### *Lubrication and Ignition*

Oil-pumps of the spur-wheel type are fitted and the lubricant is fed under pressure to both ends of the crankshaft and thence along the inside of the shaft to the crankpins and to the big-ends and piston pins. Oil is also supplied under pressure to one of the camshafts on each set of cylinders and to the reduction gears The cylinders are lubricated by oil splashed from the connecting-rod big-end bearings and the piston Two scraper rings are fitted to each piston and the oil from the upper scraper ring is drained through holes cut in the piston

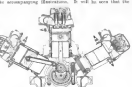
Two twelve-cylinder magnetos are fitted. They are of the AV12 type manufactured by the British Thomson-Houston Co., Ltd Both rotate in a counter-clockwise direction and one has a special distributor rotor for starting purposes. They are driven at one and a half times the speed of the crankshaft to give six sparks for each revolution of the engine, as this type of magneto gives four sparks to each revolution Two plugs are, of course, fitted to each cylinder. Those recommended by the builder are the KLG type F10.

### *Crankcase*

The crankcase of the Lion engine is a fine aluminum alloy casting. The upper halves of the housings for the crankshaft plain and roller bearings are contained in the two ends and

four internal cross-webs. The lower halves of the housings for the roller bearings are steel caps carried in studs in the rear and cross webs

The casing for the reduction gear is formed at the front end of the crankcase. The gearing is clearly shown in one of the accompanying illustrations. It will be seen that the

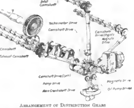


SECTIONAL END ELEVATION

arrangement is very compact. There are six camshafts, two for each set of cylinders, one operating the exhaust and one the inlet valves. Only one camshaft on each set of cylinders is driven by the reduction gear, the other camshaft is geared to this. Consequently, there are three shafts driven by the bevel gear wheel attached to the crankshaft. The diagram also shows that one shaft has two bevel wheels, one of which engages with the bevel wheel that drives the center shaft. The compact arrangement by which the six camshafts, water-pumps, oil-pumps and two magnetos are driven is clearly shown

### Details of Construction

The cylinders, which are steel forgings machined all over, are arranged in three sets of four each, one cylinder being vertical, with the other two making angles of 60 deg. with




ARRANGEMENT OF DISTRIBUTION GEARS

its center line. The bore of the cylinder is 5½ in. and the stroke is 5⅛ in. The water-jackets are of steel and the cylinder-head which is detachable contains the inlet and exhaust passages and together with the valves and their actuating mechanism is made of aluminum. An aluminum alloy is used for the pistons, which are fitted with two gas and two scraper rings. The pins are hollow, of large diameter and work in steel bushings. The connecting-rods are machined from high-grade special steel. The main rod, which is coupled to the pistons of the vertical block of cylinders, has lugs at either side which are attached to the short auxiliary rods for the pistons of the right and left groups of cylinders. The big-ends are lined with white metal and together with the anchor pins and other parts work in large bushings. The crankshaft is machined from a solid steel forging with the four throws in one plane. All the journal bearings of the crank-pins are of large diameter and are bored out. Five roller bearings and a large plain bearing at the forward end are provided for the shaft.

The water pump is of the centrifugal type and is mounted at the rear of the engine. Its speed is half that of the crankshaft and the circulating water is delivered through a separate outlet to each of the cylinder blocks. A metallic packed gland and a grease cup with screw feed are provided for the pump.

The engine has an overall length to the center of the propeller of approximately 4 ft. 8 in. and an approximate overall width of 3½ ft. The height overall is about 3 ft. The fuel consumption is approximately 0.51 pt. per b. hp.-hr. at full load and the oil consumption is 0.02 pt.—*Aeronautical Engineering*

## New N.A.C.A. Reports

Following are the titles of the technical reports Nos. 51 to 82 inclusive, which have been prepared by the National Advisory Committee for Aeronautics in conjunction with its fifth annual report:

- No. 51. Spark Plug Defects and Tests.
- No. 52. Temperatures in Spark Plugs Having Steel and Brass Shells.
- No. 53. Properties and Preparation of Ceramic Insulators for Spark Plugs.
- No. 54. Effect of Temperature and Pressure on the Sparking Voltage.
- No. 55. Investigation of the Muffler Problem for Airplane Engines.
- No. 56. Heat Energy of Various Ignition Sparks.
- No. 57. The Subsidiary Gap as a Means for Improving Ignition.
- No. 58. Characteristics of High Tension Magnetos.
- No. 59. General Analysis of Airplane Radiator Problems.
- No. 60. General Discussion of Test Methods for Radiators.
- No. 61. Head Resistance Due to Radiators.
- No. 62. Effect of Altitude on Radiator Performance.
- No. 63. Results of Tests on Radiators for Aircraft Engines.
- No. 64. Experimental Research on Air Propellers, III.
- No. 65. Kiln Drying of Woods for Airplanes.
- No. 66. Glues Used in Airplane Parts.
- No. 67. Supplies and Production of Aircraft Woods.
- No. 68. The Effect of Kiln Drying on the Strength of Wood.
- No. 69. A Study of Airplane Ranges and Useful Loads.
- No. 70. Preliminary Report on Free Flight Tests.
- No. 71. Slip-Stream Corrections in Performance Computation.
- No. 72. Wind Tunnel Balances.
- No. 73. The Design of Wind Tunnels and Wind Tunnel Propellers.
- No. 74. Construction of Models for Test in Wind Tunnels.
- No. 75. The Aerodynamic Properties of Thick Aerofoils Suitable for Internal Bracing.
- No. 76. Analysis of Fuselage Stresses.
- No. 77. The Parker Variable Camber Wing.
- No. 78. The Limiting Velocity in Falling from a Great Height.
- No. 79. Bomb Trajectories.
- No. 80. Stability of the Parachute and Helicopter.
- No. 81. Comparison of U. S. and British Standard Pitot-Static Tubes.
- No. 82. Airplane Stress Analysis.

# The Floyd Smith Aerial Life Pack

By Floyd Smith

Parachutes have been in use for over thirty years for such purposes as exhibition descents from balloons, but were first used from speeding aircraft in 1912, when Captain Berry made a descent from an airplane traveling at a speed of about 48 m.p.h. at St. Louis, Mo. He used a medium size and weight parachute, folded and stuffed into a conical cylinder which was tied underneath the front end of the skid on the three wheeled pusher biplane used. The parachute was held in the cylinder by heavy threads, and a connecting rope extended from the parachute to Captain Berry about 10 ft. aft, from which point he dropped off. As he dropped away, his weight pulled the parachute from the cylinder and it opened normally, landing him safely.

Shortly afterwards several parachute descents were made in a similar manner on the Pacific Coast.

In 1913, Pegoud made a descent from a Blériot monoplane in France, in a different way. The plane was specially fitted with a tubing guard from the seat back, over the rudder. The parachute was folded and fastened on top of this guard, and a rope connected it to Pegoud in the seat. He put the plane into a dive, reared up and released the parachute, and was dragged over the tail as the parachute opened.

During 1913 there were several knapsack types of life packs developed in America, all of the attached type, meaning that a cord or rope was attached to the pack and to the aircraft, which pulled the pack open and pulled the parachute out as the jumper dropped away.

One of these packs, the Broadwick, was very successful and a very good life pack. Tiny Broadwick made numerous parachute descents from Glenn Martin's plane during the summer of 1913 and the winter and Mrs Smith made descents with it in 1914. It was not considered any extraordinary feat to jump with this pack at five or six hundred feet altitude. This pack weighed about 11 lb. with a 32 ft. parachute, and was safe for speeds under 80 or 90 m.p.h.

Between 1916 and 1918 there were several different life packs developed in Europe, the principal ones being the Guardian Angel (English), the Mears (English), the S. T. A. (French), the Ors (French) and the Heinecke (German). These ran in weight from 18 lb. to 28 lb. without harness.

The German pack was the only one put to practical use by airmen during the war. The pack was merely a round sack, about 16 in. in diameter by 10 in. deep, and the top puckered closed by a draw wire, which was attached to the plane. The pack was attached to the harness by side straps, and the wearer sat upon it as a cushion. A cord 6 or 8 ft. in length was tied to the draw wire, and by a 50 lb. break cord to the top of the chute, so that when the wearer dropped away, the cord first pulled the draw wire, leaving the top of the pack open, and then held the top of the chute until it was broken away.

This was a very crude life pack, and yet it saved quite a number of German pilots and gunners from a fiery death.

There are four features about an aerial life pack that can give trouble; namely, means for removing the parachute from the pack which may fail, means for keeping the pack closed and preventing the parachute from getting released before the wearer is clear of the aircraft; loose parts, such as connecting ropes, that may catch on parts of the aircraft, and the strength of the parachute itself.

The Floyd Smith pack has been developed to cover all of the above mentioned features in the safest way, as well as to make a light, compact and adaptable pack.

While in charge of the parachute department in the U. S. Army Air Service at McCook Field, from January to September, 1919, the writer experimented with and tested all of the principal life packs and parachutes of America and Europe, as well as his own.

During this time two of the best known parachutes blew out of their packs before the dummy was dropped. One of them was badly torn on the tail skid, and the other cleared the tail skid and opened in back of the tail and broke its attaching rope. If such a thing happened when the parachute was attached to a person in the cockpit, it would most certainly seriously injure him. A parachute when released from a plane in flight does not open above the plane so as to lift a person out, as a great many people seem to think. Neither is it possible to throw the parachute through the slip stream so as to lift the person out, as a number of inventors have tried to do. Even by employing heavy springs and powder charges far beyond the practicability of carrying, it is only possible to throw the parachute a few feet through the slip stream, at moderate speed, and then it is blown straight backwards its own length before it starts to open, and, of course, will pull practically straight backward. It is impossible with any force, practical to carry in a plane, to throw the parachute high enough to clear the tail at speeds over 100 m.p.h.

Another quite common fallacy is that some mechanical or compressed air means are required to open a parachute. There is only one element needed to open a parachute and this is air speed, which is also more powerful than any means that a person could carry.

The parachute, generally thought to be a very delicate, unreliable and intricate vehicle, is in reality the simplest in principle and operation of many things commonly used. It is only necessary for the parachute to be allowed to blow backwards in the air and, as many points on the lower edge of the chute (the shroud) are held by the shroud lines, the air blows inside and as it cannot get out, it forces the sides of the chute out until it is fully open.

The most important point is to be sure that the parachute is released so that it can blow back, and then it must be securely tied closed if it is to be prevented from opening. The only important feature in folding and packing, so far as affects the opening of the chute, is that panels should be pulled outward at their center, leaving the shroud lines at the center.

In the Floyd Smith life pack there is incorporated a method of releasing the chute entirely, leaving it entirely free in the air stream so that it must blow back and open. The means employed to release the pack are absolutely positive, and are such that it cannot be damaged by rough usage, or time. The parachute is structurally developed to withstand the greatest speeds that the present day airplanes can attain in vertical power dives.

Future commercial and passenger aircraft will be of larger size, and will necessarily be equipped with a ladder or stairs to enable the passengers to enter. Nothing will be simpler than that these ladders be hinged forward on the bottom of passenger compartment, and after passengers have entered, the ladder be swung up, closing the opening. In case of fire or other disaster in the air, or anticipated disaster such as forced landing, out of control or in storm, the passengers can be safely landed in a very simple manner. The ladder would be pulled down and as each passenger descended they would release their pack, or one of the crew would release their pack by a jerk on the release ring, and they would be forcibly removed by the parachute without the necessity of jumping. It is only necessary for the pack to be released one foot below or out of line with an obstacle aft in the slip stream.

The writer has made one of these take-off drops from a plane diving at about 120 m.p.h. speed, at about 75 ft. altitude, and can truthfully state that the sensation of the take-off was very mild compared with the sensation of looping the loop. The sensation and danger of jumping from a steamship into the ocean with a life preserver on is many times greater than a take-off parachute drop, and yet thousands of men and women have made the steamship jump. In fact, jumping from a steamship with a life preserver on is for psychological reasons fully as difficult, and many times more dangerous than jumping from an aircraft with the life pack and releasing it while falling. In several of the live jumps with the pack, the jumper has intended to wait awhile before releasing it, but in no case could he resist the temptation to grasp the ring and release the pack for more than one second.

Many people think that when a person falls, they are helpless, cannot breathe or make a move, and the common belief

which is often expressed by officials is that a person who falls 200 or 300 feet or more is dead before he strikes the ground. The simple facts are these: that a person must fall 500 feet before he can attain a falling speed of 120 m p h. and new men are quickly trained to stand up in a turret of a plane traveling at that speed, and use machine guns on an enemy. Naturally he must breathe and move, etc. Such thoughts are merely fallacies that have grown upon the average person from childhood days.

*Instructions for Packing and Using the Aerial Life Pack*

*First* Fasten the bridle at top of parachute and stretch the chute full length as in Fig 1, with the label on shroud of chute up. In this way you will be sure that the shroud lines

Fig 1

are not twisted. Shake the chute up and down a few times to get all the slack out, and fasten the two webbs under 20 or 30 lb tension, about 1 ft apart.

*Second* Take each panel at its center on shroud, between each of the shroud lines on one side, and lay these panels over the other half. Start with the bottom panel that connects the two sets of shroud lines, and flatten out one-half of it in the cleared space, leaving the shroud line at the center. To prevent too much bulk, space the inner fold of the chute where the shroud lines run through it, from 1 to 3 in. apart. When the top shroud line is reached, repeat the operation

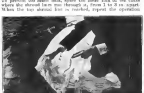


Fig 2

on the other half. It is not absolutely necessary to smooth the panels perfectly their full length, but it makes a more compact and neater pack to do so, and carefulness is a good motto to use. Many parachutists merely pick up one half of the panels at their shroud centers, allowing the shroud lines to fall to the center, and toy the folds down, and repeat on the other half, and then some stuff the chute in a sack any way to get it in.

Next, shove the two centers of the folds together, and fold the top panel, the same as the bottom one, one half on each side. Then fold the two sets of panels at their centers as in Fig. 2. Lay sand bags or any suitable weights on top of folds at shroud at about 2 ft intervals to about center of chute.

*Third* Release the webbs and tie a 15 or 20 lb weight on the webbs in such a way that it cannot fall off while dragging, or one person can hold them. Then insert the packing tool under the top of the chute, and place the cross bar 1 over the chute, and the cross bar 2 under the chute and fold the chute and repeat until the chute is folded as in Fig 3. If packing tool is not available you can fold the chute in the same way with your hands, as the chute has a black line on the top panel at the proper distances apart.

*Fourth* Grasp all the shroud lines firmly and coil them

Fig 3

over the top of the folded chute, placing a sheet of light paper such as newspaper, between each coil, as in Fig 4. The concentration rings at the end of the shroud lines should be spaced singly at about top center, allowing the webbs to extend out on the end, near top center.

*Fifth* Place the pack on top of folded chute, with the tapered end flap over webbs, as in Fig. 5. Slide the side flaps under the chute to center and turn the entire unit over so that the pack is on the bottom. Be sure the folded chute is approximately at center of pack, then pull the side flaps over the folded chute and fasten the center cone bottom

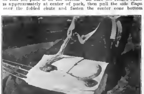


Fig 4

through grummet with end pin on release cable, the cable having been passed through the flexible housing guard. Smooth the top folds of the chute towards side and down on edges.

Next, take the pilot chute by its concentration loop at ends of shroud lines, hold it up and see that the shroud lines are not twisted. Place this loop over a nail or hook and take the pilot frame at top and close it. Grasp the entire folded pilot chute around the center with one hand and the shroud lines with other hand about 1 ft from shroud, and hold in



vertical position, allowing the outer edges of chute to fall down outside, until shroud is about even with ends of frame ribs. Pull the panels out between ribs so that ribs are at center. Grasp the entire folded chute near ends of ribs and pull away from concentration loop until the shroud lines are even. Tie the concentration loop to the bridge on vent of main chute with cords totaling in strength 400 lbs. Lay the pilot chute shroud lines crossways on top of folded main chute several times, and slide the top of pilot chute under the fastened cone button toward the top of pack, until the pilot chute is laying at about top center of entire pack above its own shroud lines, in Fig. 6

Smooth the folded chute out in top corner of pack and fasten the top cone button and grummet on side flaps with

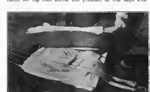


Fig 5

central pin on cable. Press the end centers of side flaps down over chute and pull the webbs over same and hold down. Then pull end flap over all and, after pulling the pin, place the end flap grummet on cone, and pin with first pin on cable. Replace the end pin at center of pack with center pin, and fasten the side flaps on top of end flap at bottom of pack with end pin. Safety tie with 10 lb to 15 lb thread. Button guard flap over all.

The main harness lift webbs should be tied over the shoulder webbs with 40 lb. to 60 lb cord, at the connecting ring, with release cable housing between.

If connecting snaps are used on webbs from parachute, connect them to the connecting rings on harness, and stand the pack in seat with seat strap forward so that when you sit down it will be under you. Put your arms through the shoulder loops and snap the lap or leg straps snugly but not tight. Snap the breast strap and the pack is ready to be used on instant notice.

The simplest way to get out under normal flight conditions is to place both hands on side of cockpit if you are aft or forward of obstructions, and vault out, taking the release ring with left hand preferably, while dropping side of fuselage or boat, and unless you have a very strong constitution you will pull the ring before you have dropped 10 ft.

It is best to jerk the ring instead of a steady pull, but there is no serious meaning attached to this. As an illustration, one man while making his first jump with this pack was observed very closely by the writer. His release cable was safetied with a 20 lb cord and his pack was of an old type and was loose vertically on his back. He pulled easily and steadily and when nothing happened, he looked up and got full of action, and jerked the release cable out full length and threw it away with the one motion. The chute opened in 1 3-5 seconds after he had jumped, which goes to prove that instead of being helpless while falling, a person is in reality more active than at other times.

A warning is given not to stand up and jump into the tail or the wings if you are sitting in front. At the same time, you do not need to be afraid of being blown into rear obstructions if you vault out with one hand near front of cockpit, or if you drop off from steps or any other part of the plane, except possibly if it is a very steep climb with motor wide open.

If the plane or ship is of a type that you can attain a position to one side or below where there is nothing aft in the slip stream, you can simply release the pack and allow the parachute to pull you off. In this method of drop, there is practically no sensation other than flying.

In case of explosion, dangerous fire, collapsed plane or fall off into spin at low altitude, it is best to vault, or to get out in the quickest way possible and release the pack as soon as you are on your way. You are especially cautioned not to take hold of release ring while climbing or before you actually start the drop. This is important as it is much more dangerous to release the pack with obstructions behind in

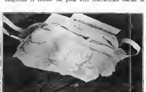


Fig 6

slip stream than it is to drop several hundred feet before releasing it. It should be borne in mind that a person must fall 500 ft. before attaining a falling speed of 120 m p.h.

In case of a fast spin out of control, get out the inside and you will be thrown outside the spin circle, passing between wing and tail; by releasing pack as soon as possible after leaving, you will be well outside circle and from 50 ft. to 100 ft. above plane on its next time around.

A slow, flat spin is the most dangerous to get away from because the occupant will not be thrown outside the circle, and the plane might come down on top of occupant after the chute had opened. It is never likely to be necessary to get away from a slow flat spin, but if it should be necessary, it is best to climb to top wing and release the pack for a take off.

In case of fast side slip out of control it is best either to vault out, or drop off and release pack after away, or if aft of wings, stand up and release pack for take off.

In case of dive out of control, vault or jump out, or drop off and release pack after away, or get to point where nothing is aft in slip stream and release pack for take off.

In a power dive with tractor plane, it is practical to climb up the tail to top of stabilizer and to take off, but not necessary as a person will fall from the plane if they get out, and can release the pack normally without danger of fouling the tail, or falling in front of plane.

It is possible in case of out of control dive or fall off at low altitude, such as under 200 ft., to jump straight up or to one side and release pack at same instant while jumping, and be stopped by chute before the crash. In many instances of this kind, you would no doubt be struck by tail parts or wires, but not necessarily seriously hurt because the plane would be traveling very little faster than yourself. In the large majority of such cases, it would no doubt be much better than being in the crash. In such cases while sitting in front, lunge out and under wings and release pack.

In case of lost motor in tractor and tail slide, get to top or front of wings and release pack for take off. In all cases, make every move methodically and you will find that it is not so difficult to get away from any aircraft by parachute, as many other things commonly done.

While descending it is necessary to watch drift and it is possible to slide the chute about 50 ft. to each 100 ft. descent by pulling the shroud lines down about 1½ ft on the side that you wish to slide Do not be alarmed if that side of the chute is pushed in nearly to center, as it will open again. You can stop a spin by pulling one after another of the quarters of shroud lines, working around in opposite direction to spin

Fig. 7

You can stop a swing by simply pulling down on shroud lines on rear of swing, the same as in a child's swing, or you can swing yourself onto a building, or off a building or tree or wires by pulling down sharply with all your weight on half the shroud lines in the direction in which you wish to swing

When nearing the landing, reach up and wrap the landing cord around your hand, then watch closely and just before landing, pull down sharply on the cord, and your rate of descent will be reduced about one half

When landing in high wind on land, unsnap the breast strap, take your arms out of shoulder loops and unsnap the lap strap while descending so that you will be sitting in seat strap, and free from harness when you land

In any case, when landing, have your legs slightly bent, and do not try to stand up If you weigh 175 lbs. you will only be descending 16 ft per second, equal to a drop of 4½ ft., and if you use the landing cord, 8 ft. per second, equal to a drop of 1 ft., but while descending you feel like a feather floating, and you are apt to land stiff legged if you don't watch your landing Land with the intention of sinking down, and do not try to twist or swing while landing, unless it is necessary to get on or away from a building or tree or wires

If you land in water in stiff wind, leave yourself attached to the chute, and it will pull you along on top of water, unless it would take you away from a boat or land. When landing in water in still air, the chute will usually slide off on one side, but it is best to start swimming immediately and take no chances of entanglement with shroud lines.

Last, and what is considered a very important point, there should be ground schools established by mounting a plane about 20 ft in air, and a net placed underneath, and all regular airmen should practice jumping in different ways and pull the release while dropping with motor running wide open In this way airmen will get familiar with getting out, and with the pack, and know for a certainty that they can operate it while falling It is better than nothing even to block the tail up on the ground and practice jumping while motor is running. During all such practice, the pack can be tied so the release can be pulled without letting the chute out

We advise that any parachute pack should be tested once every two months with about 300 lb dummy attached, at a speed of 100 m.p.h or more, and the parachute examined

Fig 8

and repacked The parachute should at least be taken out and aired every two months, although it would no doubt be good for a year A parachute should never be packed wet or damp

## New Navy Aircraft

Construction of two giant seaplanes, twice the size of the transatlantic NC-4 and larger than any in the world, is planned by the Navy Department, according to a statement made on Feb 7 to the House Naval Committee by Capt T. T Craven, director of naval aviation He asked for $636,000 for this work and proposed a naval aviation programme costing $12,890,000 for 1921

Besides the two big planes Capt. Craven recommended four new NC planes, 150 smaller ones, one large rigid airship costing $2,700,000, three smaller non-rigid airships, thirty-eight kite balloons and six free balloons

Capt Craven said Great Britain and Italy were planning to build planes similar to the large ones which the American Navy hopes to complete in eighteen months The American machines would have a gross weight of thirty tons, a wing spread of 140 ft, and would be capable of weathering high seas if forced to land on the water, he said.

## To Bar Helium Export

Congress was recently asked by Secretary Daniels to prohibit the export of helium and to impose five years' imprisonment and $5,000 fine for violation of the export ban. He said

"The demand for helium abroad is insistent and great enough to consume the available supply in this country in a short time."

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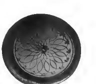

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